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THE FACTOR OF SAFETY IN RESEARCH[1]

ONCE in the drear dead days unfortunately still fresh in memory the head of a great institution for the aid of education wrote, with reference to research, these words: "In the last two decades more sins have been committed in its name against good teaching than we are likely to atone for in the next generation." Evidently the time of reformation had not arrived when this disparagement was uttered, for some ten years later the same pen recorded history as follows: "Much of that which has gone on in American universities under the name of research is in truth only an imitation of research."

To some of you, more than commonly zealous in support of investigation and with a background of rural experience, these words may come with memories of the odor of new mown hay and visions of waving yellow fields and the reflection that excessive heat sometimes causes mental aberrations. For the quoted passages could have come only from an annual report, naturally written just after the end of the fiscal year; but unfortunately for this simple explanation, the fiscal year of the institution in question does not end in June, and the derogation of research was conceived in the cool gray days of autumn. Moreover no charge of alienation of reason could be brought against the author of these rebukes that would not lodge with equal justice in other quarters. The chief executive of another great institution which has done and is doing as much in the field of research as any of its kind in America voiced a similar sentiment thus: "Quite too much attention is paid to those who when they make some slight addition to their own stock of information fancy that the world's store of

[1] Address of the President of the Michigan Academy of Science, Arts and Letters, March 29, 1922.

knowledge is thereby increased by a new discovery." It is not fair in this case to remove the quoted words from their context, which was really a commendation of research as a university function. But in view of the wariness with which such views are expressed in public, the slight stricture here permitted to appear is probably only the weather-worn outcropping of a stratum much more extensive.

Indeed, it is not an uncommon idea even among men actively engaged in investigation that there is a fearful waste of energy upon research that might as well be left undone. Has it not been pointed out in every discussion of cooperation in scientific work how much better would the world be served, could the labor now being frittered away upon unimportant matters be organized under the direction of some one capable of separating the wheat from the chaff? A few years ago Edwin Linton, in an appreciation of Spencer Fullerton Baird, who must have been a practical person to have deserved the commendation bestowed upon him, wrote: "I am led to wonder if the failure of science to influence legislation in the interests of the people is not to be charged to the propensity on the part of these leaders to shun the practical." Likewise the energetic chief of the Federal Bureau of Entomology, on looking through a collection of doctor's theses with the interests of his own bureau in mind, finds "that only a very small percentage of this output represents work which can be of the slightest use to humanity in its immediate problems regarding the insect world." "At present most of the best men are working away in their laboratories practically heedless of . . . the tremendous necessity for the most intense work by the very best minds on the problem of overcoming and controlling our strongest rivals on this planet." Had Dr. Howard been a physicist, or engineer, or metallurgist, he could no doubt have changed a word here and there and made the same statement with equal vigor. Those of you who every May have scanned a series of doctor's theses may wish to explain in some other way the fine despair with which he exclaims, "And how can we emphasize the prime importance of devoting our earliest attention to those problems which most immediately concern our well being."

These are not the only investigators who have views that substantially agree in regarding much research as wasted, and the number who are willing to express such views in public is presumably but a fraction of the number who hold them in private.

Research is not, it is true, alone in including much which is of no direct value. How much of literature could not be suppressed, to the advantage of author, publisher and reading public? Is there not much of so-called art which might never have been born, and leave the world happier for its non-existence? However, to recite the ills of sister lines of endeavor is not to cure or even excuse our own.

But are they ills? Is it to be in any wise deplored that the research by which John Brown wins a degree, or Professor Jones keeps his mind fertile while teaching, is not of the sort that promises to lighten the burdens of human society or increase its means of pleasure? At least, is it to be deplored to the extent that Student Brown and Professor Jones should have refrained from research if they were unable to fix upon a more practical subject of investigation? I believe it is not only *not* to be regretted that some pieces of research must seem trifling, but that the system under which we now operate, in which unimportant or perhaps in themselves valueless contributions are sometimes made, accomplishes a greater result than any system that could be devised under which such insignificant researches would be excluded.

Let me disillusion at once those who imagine that I am about to defend research on the ideal ground that truth for truth's sake is indeed practical, and that therefore any investigation which discovers a grain of that precious commodity is an economic gain. I would be willing to make such a defense if it were desirable to pitch the combat on so high a plane. But it is no time to wrestle with the angels above the clouds while the forces of evil are unvanquished in the valley. I have no intention of discussing at length what is practical. Perhaps one should regard general knowledge as the most practical kind. The elimination of *ennui* and of the loose habits formed in the periods of mental vacuity to which the ignorant and the merely technically trained are

frequently subjected may result in improved health and increased longevity, and so be a highly practical matter. An engineer or a physician seldom reaches the economic heights of his profession without the engaging or compelling mental exterior which only a general education can develop to the full. One need not admit that only those things are practical which look practical to the world at large. One need not even admit that a thing is useless even if it could be known—as it can not—that no better food supply, or no decrease of hardship would ever come out of it. The conception of the practical which makes it include general knowledge is capable of strong support, but I shall not avail myself of it. I propose to accept, for the purpose of this address, the definition of the practical as given by the man in the street.

Nor have I any intention of deciding whether a practical education is the best one. So far as I can see, the whole science of astronomy might be forgotten, and my present daily life would go on about as before. I would enjoy the sunlight and profit by its energy as I do now. The seasons would follow one another in the same order if we were ignorant of the causes of their succession. The eugenic effects of moonlit and starlit nights would be as great as at present. Should the navigator who brings me comforts from distant parts of the globe get into trouble, that difficulty could soon be obviated. But one element of vastness in the thoughts of men would be gone forever, and it is not unlikely that experiences of other kinds would shrink in proportion. What physical advantage, gained by devoting to some applied science the energy now devoted to the planets, could compensate for such a loss?

It is not my purpose, however, to address myself to idealists, though no doubt that is the character of this audience. Arguments on a lower level are now much more urgent. We are all familiar with the investigations which have been undertaken for the simple purpose of discovering scientific truth, but which afterwards have led to results of the highest practical importance. Biologists know by heart the story of Professor Harrison who by painstaking experiments devised a means of keeping alive a small group of cells after removal from the body of the animal to which they belonged, and of watching them grow under the microscope. He was seeking to demonstrate a principle of morphology and development, and he succeeded to the satisfaction of himself and his coworkers. Neither he nor they considered the possibility that his method of tissue culture would ever be used to the obvious advantage of man. But this method was later used by a great surgeon, who kept tissues alive for years and who pointed out the possibilities which the method contained of disclosing the causes of death and thereby of prolonging human life. Thus the experiments first used to settle a disputed question of biology promise, in the opinion of many, to bring us nearer to that oldest of human goals, the fountain of eternal youth. The possibility of practical advantage to be derived from these culture methods weighed heavily in the allocation of the Nobel prize in medicine which was bestowed upon the surgeon. There should be no detraction from the credit due to one who has the vision to discover new uses for old methods, but rather increase of credit to the original discoverer. Professor Harrison would be the last to ask that the Nobel prize be transferred to him. All he would ask is that research in general be supported in a broad way which will occasionally make possible further practical applications.

Perhaps less generally known is the recent improvement of submarine cables, whereby their capacity is increased five-fold. Experiments extending over a long period of time had as their aim improved insulation which would prevent or reduce leakage. These efforts succeeded to a marked degree only after another worker, with the mere advance of scientific knowledge in mind, invented a new alloy having the desired insulating properties. The field of physics is full of such examples. The work of Maxwell on the electromagnetic wave theory led to wireless telegraphy; Roentgen's rays were discovered in the course of a piece of pure research; and, indeed, all of the early work on electricity was done in a spirit of investigation having no other object than to discover the truth.

What might have happened to these discoveries had they promised to emerge in an atmosphere in which it was considered that "much that has gone on in the name of research is in truth only an imitation of research," can only be surmised. Whether they would have been made in the laboratories of an institution where they stood a chance of being regarded as "sins against good teaching" so heinous as to demand expiation for a generation, may be doubted. Even if their worst prospective reception had been that of being regarded as slight additions to the discoverers' own stock of information and not an increase of the world's store of knowledge, their origin could hardly have been inspiriting to their author. One pauses to meditate upon the reasons for the long delay in the appreciation of the work of the Abbé Mendel in hybridization of garden peas, and of that of Willard Gibbs on the "phase rule," and to wonder whether even then men in positions of influence were convinced that they could "spot" in advance those things which were worth doing.

It would be hazardous to assert that cases as striking as the foregoing are common. Less spectacular examples are, however, not rare. Although many of the economically valuable applications of science to practical ends are directly made by investigators who are consciously striving to make those applications, it is probably in every case true that their success has depended upon previous discoveries not made with a practical aim in view. Some one has gone so far as to say that every discovery of science which has proven of economic use was first made as a contribution to pure science.

Justification of research along lines that promise no amelioration of man's condition must not, however, lie only in the possibility that the amelioration will result even without the promise. Some investigations must be carried on purely for the training of investigators. Until, by use of tissue cultures or an analogous procedure discovered by the pure scientist and then applied by others, some means of indefinitely prolonging life is discovered, new investigators must be developed to replace the old. New investigators are developed only by practice, and in practice they must solve problems. For this educational work a problem of small value often serves as well as a weightier one. Indeed, since first attempts often show the hand of the novice, it may be doing a real service to science to withhold the more serious problem for a second or later investigation. It is not reasonable, therefore, and perhaps it is not wise to insist that even the training of research students shall all be done on subjects that are in themselves of high value either directly or indirectly. Objecting to our system of traininig in research by means of small investigations that are not in themselves important is like proposing to abandon the study of arithmetic by means of problems on the ground that no one ever bought seven gallons of vinegar at twenty cents a quart, and that therefore it is a waste of time to discover how much the liquid cost.

To convince ourselves that the rearing of young investigators on a diet of insignificant problems is not inevitably fatal, and that it may even be beneficial, it is only necessary to look backward instead of forward, and gather assurance concerning the future from what has happened in the past. Did Pasteur, for example, learn the art of investigation on a problem that he foresaw was to be a lasting boon and cause of untold happiness to men? This being a presidential address, I will probably exhibit no greater degree of ignorance than is to be expected if I inquire whether the solution of a puzzling problem relating to the isomeric tartaric acids was by any one at that time held to be full of economic promise. Molecular structure we may regard to-day as of high importance, perhaps in some instances even in a practical way, but hardly in Pasteur's early manhood. That his researches were considered by his contemporaries futile, even from the pure science viewpoint, is plain; for when Pasteur's reputation had been established, when he was professor of chemistry, even when he was dean of his faculty, than which no higher honor presumably could come to a man of science, he was advised by Biot and Dumas, veteran chemists, not to waste more time on the subjects which were then uppermost in his mind. These investigations led, however,

through the chemistry of fermentation to the bacteria of fermentation, and thence to the organisms of disease, and to-day the appreciation of the practical value of Pasteur's work is universal.

We may be told that Pasteur could have started midway in his career if some one had put him there at the outset by advice; and if we reply that there was no such person to advise him, we may be reminded that there are plenty of advisers to-day. These advisers are precisely the foundation on which those who decry the uselessness of many present investigations propose to build a system in which only useful and important projects are undertaken. Granted an abundance of omniscient advisers, their plan should work; but if these foundation stones prove defective, the structure resting on them will fall. How readily such advisers may be discovered and drafted into service is perhaps capable of computation. No doubt each person who proposes to eliminate uselessness in research has in mind at least one who is able and willing to undertake the task of elimination. Otherwise the proposal would hardly be made. One need, therefore, only count the number of those who would dispense with impractical investigation to determine the minimum number of advisers with which the system might start. Probably there are others having ability, but also modesty, who can not be immediately discovered. So far as I know no one has attempted to determine how much leadership a federation to prevent uselessness in research might count upon.

There is danger in this connection that the controlling factor of a career be misjudged. Careers are only occasionally guided by advice; for the rest, they are the product of evolution. Each step depends on what has gone before, and determines what shall come after. Granted the characteristics with which Pasteur's parents endowed him, his life proceeded naturally from one thing to another. One need not be a fatalist to conceive that the only way for him to end with proof of the germ theory of disease was to start with isomerism in tartaric acids. Had he been artificially set down at some mile-post on the way, without having traversed the preceding distances, it is questionable whether he could have been made to follow the same road, even with the help of advice from those who believed they were qualified to give it. Without the abiding faith that he was on the right road, which only his own previous work, not the suggestions of his elders, could give him, it is scarcely likely he would have persevered through the long periods of discouragement. To him who asserts that Pasteur could have been put upon the problem of pathogenic organisms in his early days and have reached the goal of his maturity at an earlier date, the only suitable reply seems to be the verse which might prove to have apostolic origin if the Scriptures recorded everything, "Verily, optimism hath its own reward."

Had Pasteur's hypothetical early start on pathogenic organisms failed to lead him to the present conception of the etiology of disease, what would have been the damage? Would the world simply have lost Pasteur, and never been the wiser, in the same manner as it has probably lost many another genius, perhaps through mistaken advice coming from those who were supposed to know? Could humanity have counted on a substitute for Pasteur, arising at an equally early date and arriving, either with or without advice from superiors, at the same conclusions as Pasteur reached? It is not likely. Failure to discover the truth by Pasteur would have been a calamity. His work would have been careful, painstaking. Everyone watching his later career would have recognized that his work on the theory of pathogenic organisms must have been thorough. But, owing to immaturity, or want of perseverance because he lacked the faith in his own hypotheses which only gradual development of them could insure, it had demonstrated nothing, its results were negative. Surely this would not have been an encouraging fact for any one else who conceived the germ theory of disease and contemplated efforts to prove its correctness. The oligarchy set up to guide research in useful directions would hardly have advised young men, or others, to enter that field. The fact that careful work by an able investigator, even if then young, had failed to find any proof of the bacterial origin of disease, could easily have damned the truth to a generation or more of undiscovery.

If any comfort is to be taken in the gloomy

picture of what would have happened if Pasteur had, at the behest of some supervising agency, undertaken as a first problem something else than the isomerism of tartaric acids, and thereby missed the germ theory of disease, it must lie in the belief that a man of Pasteur's timber would have done great things in another field. But such a consideration does not answer the argument that his early work, practical or not, was a necessary training in order that his maturer work might be valuable.

Doubtless the case of Pasteur can be duplicated by that of other eminent scientists whose first research seemed to bear no relation to their later high attainments. Perhaps that is regularly true, except in the small number of cases in which by the laws of chance it is to be expected that preliminary work and eventual important discoveries shall lie in the same field. The fields in which the accomplishments of great investigators lie may thus appear to be matters of accident; but then, an accident is but the inevitable consequence of other accidents that have gone before.

If it is not fatal, but sometimes even useful, to start the new investigator on his way with a problem whose solution promises no practical improvements in human affairs, what is to be said of those who are mature in research? Probably most of these trained workers would be better satisfied with their showing to their fellow men, even if not more content with themselves, if they could be perpetually engaged on practical projects. Even if it be granted, as has been done in the introductory remarks of this address for the sake of limiting the discussion, that practically useful investigations are the only ones desirable, is it possible to maintain a system of research in which only practical things are attempted, and make it work? For various reasons the practical problem that suggests itself to an investigator may be one which he can not undertake. Lack of facilities readily accounts for many such cases, geographical position for others. The problem that seems most feasible may not seem highly important even from the pure science point of view. What is the investigator to do under these circumstances? Refrain from undertaking a problem which he feels sure is not of great value? Even if that means doing no research at all? Perhaps. But if he decides to keep on working, he may take comfort in the story of the foolish virgins, and reflect that in his small way he is keeping his lamp trimmed and burning even at the cost of some oil which seems wasted, until the bridegroom cometh with a problem that is more worth while. For nothing is so quickly fatal to research as interruption of it. This university furnished, for valuable war work, some investigators whose previous work was regarded even by themselves as of small value. I am not speaking of any of you here present. The gentlemen to whom I refer are in their laboratories to-night. They find the labors to which the great conflict introduced them so pleasurable, nay, even enthralling, that they have no time to listen to mere presidential addresses. The life of any eminent scientist of the present generation would probably furnish a further example of the *ad interim* value of unimportant research. At least this is true of those in my own field upon whom I have taken the trouble to reflect. They have engaged in continuous investigation, the continuity being due in part, in every case, to insignificant productions. It is very seldom, and then only under unusual circumstances, that a serious interruption is followed by a return to high productivity.

Nor must it be forgotten that many men who are engaged in research of minor value are the trainers of new investigators who may be more "lucky" than themselves. I think with profound respect of the professor of physics in a small western college who keeps working in a small way, who has never made a striking contribution, practical or otherwise, to his science, but who every year or two sends to a great eastern university a graduate student. Although these students are most of them still young men, they have done creditable things, some of them practical. Is it likely that the professor in the small college could thus inspire his students to a career of learning without the stimulus that comes from his own research? You may answer this question to your own liking, as I am doing. In a vicarious way, this man seems likely to exert upon his science an

influence out of all proportion to the immediate significance of his own investigations.

My challenge to the critics of the present system of research to produce anything better does not rest on the idealistic argument that truth for its own sake is the highest aim of the scholar. This argument might not appeal to those for whom this address is intended, who, while not present in this audience, may yet receive the challenge. It rests on the demonstrated fact that many discoveries thought unimportant when made have proven to be valuable later, on the belief that new investigators are often as successfully prepared by unimportant practice problems as by more fundamental ones and with sometimes less danger to the progress of science, and on the assumption that the continuity of labor which problems of small value permit is conducive to aggregate high productivity. This is the system under which we now operate, a system which leaves the individual free, and which does not chide him too severely if he sometimes engages in insignificant labor. It is a system which provides for the doing of many services in order that some of them may prove valuable. Can it be improved upon? Quite possibly. Can it be improved upon by attempting to suppress all efforts that seem to have no significance? I think not. The principle of this method is one which has been widely adopted in other affairs of life and has been found good. Firing a whole cartridge full of shot in order that one ball may bring down the game is a recognized principle of the huntsman. Is the remaining shot wasted? It is. Is the system which uses cartridges of shot, most of which is wasted, an uneconomical one? Any hunter will tell you it is not. The bullets of a machine gun are mostly wasted, but the system as a whole insures hitting the mark. Drilling wells that never yield oil is wasteful; but the system of drilling numerous wells where there is a chance of striking reservoirs is a profitable one. Casting bread upon the waters, to return again sevenfold in the form of flesh of fish, would be much more profitable if all the bread, instead of being cast at random, could be put into the mouths of those fishes that were afterwards going to be caught, and denied to those that would later escape the net. But could such individual feeding be carried out? Not economically; not even at all. Casting bread upon the waters is the easiest and least wasteful way of obtaining a return. Hundreds of inventions are made for every one that fills an important place in human economy. Numerous excursions, genuine or spurious, were necessary before the north pole was discovered. Business concerns by the hundred are established and succeed or fail, but by only a few of them is economic progress made. Thousands of students must be gathered into colleges, so that a few scholars may be produced. Even presidential addresses are subject to the same rule. In order that a few of distinction may be produced, many that fall short of the goal must be written and heard. If presidential addresses must be had, trial and error is the only way to secure quality.

The factor of safety has been employed for æons in animals, which waste millions of eggs and spermatozoa to insure continuity of the species. Professor Jennings, in one of the brilliant presidential addresses to which reference has been made, pictured himself as the accidental product of union of one among thousands of eggs and one among millions of sperms, and congratulated himself on being with us. We congratulate ourselves on having him with us. Along with Jennings, it is true, we have to accept a lot of inferior persons. We even have to take those who decry research because much of it is useless. But these disadvantages, these wasted combinations, are what insure such as Jennings. Only a small percentage of seeds ever germinate, and fewer still ever mature. The entire struggle for existence is based on the principle that security and advancement are best secured through wasteful over-production.

So in research. To find radium, we must permit scores of fruitless efforts in chemistry. To invent the wireless telephone, there must be numerous investigations that concern humanity little or not at all. To discover the mechanism of heredity, some one must be permitted to do much that has little or no bearing either upon that or upon anything else worth while. The great advances of the theory and

practical employment of electricity, of industrial chemistry, of immunity, of surgery, all have been made at the cost of much plodding and puttering. It is doubtful whether they could have been made in any other way.

The foregoing defense of the present freedom of the investigator is not to be regarded as a recommendation of still further freedom. It is not proposed that young investigators shall be delivered from all advisers. No muzzle is to be placed upon those who have comments to make upon the value of the work of their colleagues. Restrictions laid upon advice and criticism are likely to be as dangerous as restrictions imposed upon problems for investigation. All that is insisted upon is that no such advice or criticism shall carry with it any weight that is not inherent in the advice or criticism itself. Those in whose hands lies the power to make or mar the career of investigators should be exceedingly cautious how they create an atmosphere that seems in any way to discourage or limit the freedom of research. I have referred in my introductory remarks to several instances in which responsible officials have, in my opinion, transgressed in this regard. They are not the only ones, and there are other ways of committing the same sin. One of these ways is the appointment of an investigator to a position for the purpose of studying a certain problem. There comes to my mind one such appointment in a research institution. The appointee was, in his own words, "brought down here to study ———" —but to name the specific problem would be to name the institution. He did not feel free to attack another problem until that one was solved. It made no difference that he had come vaguely to feel that the problem would never be solved. or that other investigations would yield greater returns. By the terms of his appointment, his energy could be directed into other channels only with the permission of his superior officer. Such direction from above could be justified only in the case of an assistant or an investigator on temporary appointment, not in the case of a permanent colleague. Research in a general field may legitimately be the aim of an institution in the appointment of an investigator, and the appointee would naturally be one who had demonstrated an abiding interest in that field; but even in such cases, the progress of science demands that he be free from restraint.

Very different from such interference is the friendly advice of a teacher or the criticism of a colleague. Advice and criticism carry no concealed weapons. They are sometimes good, and to repress them eliminates the good with the bad. Indeed, good advice is more easily frowned down than is the bad. If my argument were regarded as against the giving of advice, and were taken seriously, those whose advice is best would be the most restrained by it. The greatest freedom of suggestion from all sources is advantageous, for advice is sometimes good, and to get what is good one must also hear the worthless. That is the reason for this address—and this statement may be interpreted in any way you choose.

To sum up, a successful system of research, even when the practical is the ultimate aim, demands the greatest freedom of the investigator. While direction from superiors may effect gains in limited fields, the losses entailed in the whole system are probably invariably greater. Great industrial concerns maintain staffs of workers whose tasks are assigned to them, and such startling achievements as the wireless telephone have resulted from their directed energies; but the responsible heads of these enterprises recognize that untrammeled research in pure science must precede and build the foundation for their labors, and some of these industrial institutions are now deliberately maintaining research workers in fields which promise at present no practical results whatever. The freedom which is insisted upon for the investigator will, it is expected, often lead him to problems that have no practical value, or even no great scientific value. But a system in which such liberty is a cornerstone insures a continuous output and a wide range of results. Among these results are most certain to be some, perhaps many, of practical value. Any interference with this system which would limit investigations to those of supposed importance would interrupt their continuity, limit the output, restrict the variety, and defeat its own purpose. The development of a scientific

foundation is an evolutionary process. Man has never yet interfered very successfully with the great scheme of organic evolution, and there is no reason to suppose that he can propose a superior substitute for the evolutionary process in the development of science. Selectionists have practically abandoned the belief that they can create new things at will, and are content now to discover, preserve, and combine what already exists or what may come into existence without their aid. Practical scientists may well take their cue from the selectionists, permit investigation to take its own course, and choose from among its products such as seem capable of application.

A. FRANKLIN SHULL
UNIVERSITY OF MICHIGAN

WHAT BECOMES OF THE FUR SEALS

THE census of Alaska fur seals in 1921 as computed by Mr. Edward C. Johnston, of the U. S. Bureau of Fisheries, amounted to a total of 581,457 animals, exclusive of 22,546 surplus males which were killed for commercial purposes. This is a low but substantial increase of 5.2 per cent. over the figures for 1920. The annual percentages of increase of the class of breeding cows since 1912 have been as follows:

1913	12.54
1914	1.06
1915	11.02
1916	12.99
1917	9.44
1918	11.63
1919	9.97
1920	6.59
1921	5.22

Since it is this class which is the controlling element of the herd it will be instructive to examine these figures with considerable care. In the first place, the great variation from year to year in the rate of increase is most noticeable; but it is no greater than that which is found to exist on the several rookeries, as an examination of the complete reports published by the Bureau of Fisheries will show.

To some persons the above figures may appear satisfactory. Every year since the cessation of pelagic sealing in 1911 a gain has been shown, whereas a loss was sustained from 1886 to that date. It was during this last period that uncontrolled slaughter of the females developed and threatened the very existence of the species before it could be checked through diplomatic channels.

Others will doubtless ask, "Why have the increases been so low?" A species of animal the female of which brings forth one young each year and approximately ten in a lifetime should increase annually more than 8.98 per cent. on the average. But that is all that an average of the above percentages will show.

Several facts have been learned the past few years which throw some light on this important subject. For instance, it has been found in several successive years that only one half of the females which are born live to be three years old. The loss of the class on the islands before the pups learn to swim is about one per cent. It varies from three fourths of one per cent. to one and one half, depending entirely upon how many bulls more than necessary are present on the rookeries. The annual loss of females through actual killing on the islands does not exceed 75, or less than five hundredths of one per cent.; all such deaths are purely accidental and largely unavoidable in the conduct of commercial work.

Therefore, the loss can take place in but one other place and that is in the sea. The figure of 50 per cent. loss the first three years was obtained in the following manner: The loss of breeding females, due to old age, is about 10 per cent. each year because the average breeding age is about 10 years. If this 10 per cent. be deducted from the number of breeding females in any year, say 1915, the remainder will represent the breeders of that year which remained alive in 1916. If this be taken from the total number of breeders in 1916, the last remainder will represent the increment of new three-year-old cows that year because the first young are born the third year. In several seasons this increment has been only about 50 per cent. of the number of female pups born three years previously. In other words, the loss amounts to one fourth the total number of births in any one year. Out of the females born during the last nine years, therefore, the following losses have been suffered:

1912	20,246
1913	23,067
1914	23,312
1915	25,881
1916	29,249
1917	32,006
1918	35,728
1919	39,293
1920	41,881
1921	44,163
Total	314,831[1]

The great question is, "What has become of this enormous total of 300,000 female seals?"

Some are killed by unlawful pelagic sealing. A few bullets and buckshot are found in the carcasses of males almost every year on the killing fields, although no seal can be shot legally. The number so killed, however, must be insignificant and the work sporadic in character up to 1921. While it should not be ignored by any means, it is not sufficiently great to concern us in such a broad analysis of the subject as we are here making.

Some other females are lawfully killed at sea by Indians under the provisions of the treaty of December 15, 1911. The number so taken in any one year is not excessive, a few hundred at most, yet it is sufficiently great that it should be stopped. The object of the treaty mentioned was to abolish pelagic sealing so as to protect the female seals. Therefore, permitting the work at all defeats the main purpose of the agreement and the objectionable clause should certainly be amended at the first opportunity. The Indians were given the privilege because they had hunted seals at sea from prehistoric times. There are many ways in which the natives can be recompensed without permitting them to destroy the important element of any species of wild life.

There is no evidence of any loss of seals at sea due to disease or starvation. The animals are always fat and healthy when they leave their island home and also when they return. Exceptions to this rule are so rare that they may be entirely ignored.

There is only one other known method by means of which the herd suffers a loss in the sea. This is the result of the depredations of killer whales. Each spring and fall these "wolves of the sea" come about the Pribilof Islands in schools and have been seen to devour seals in large numbers. I once saw a school capture three seal pups in less than five minutes. In their eagerness to capture their prey they sometimes "run aground" and of course then die. The stomachs of two which thus came ashore were once examined by Captain Bryant and in them he found 18 and 24 seals, respectively, $2,000 meals each of them.

That the destruction of seal life about the islands by the killers is very great is incontrovertible. Whether it continues as both animals migrate southward is unknown. We know with a fair degree of accuracy the direction and distance traveled by the seals but the habits of the animals during the long period of their lives when they are in the water are practically unknown.

There may be other pelagic enemies besides the killers, but it is doubtful; if so, they are entirely unknown.

Of course, the males suffer as great a loss as the females and there is some evidence which indicates that it is even greater. As a class the former do not swim so far to the southward, and it is possible that the killers normally remain in the colder waters. At any rate, we know that 300,000 of them have been lost during the past nine years. If they had been taken commercially and their skins sold for revenue they would have brought the enormous total of $15,000,000, upon the assumption of a value of $50 per skin. But during much of this period they brought $100 each or more.

Such financial loss to the government can not be passed unheeded. That sum would have paid for all of the scientific investigations, good and bad, which have ever been made of the fur seal. Each year the actual loss amounts to more than $1,000,000.

It has been urged that a small part of this be used for the study of this new "fur seal question." Seldom does a scientific investigation

[1] It should be explained that in fur seal census computations, while the figures appear exactly as though a precise enumeration had been made, only round numbers are intended to be implied. The possible error in the above computations would be approximately plus or minus five per cent.

have such a chance to show immediate financial results as this. If the activity of the enemy could be reduced one per cent. it would increase revenue over $10,000 per year.

It is therefore suggested that the activities of the killer whale be thoroughly investigated in its relation to the fur-seal herd. To do so, will require the services of a well-equipped vessel. It should be provided with a whale gun and a man to shoot it, because some of the animals would have to be killed.

The stomachs of the killers taken should of course be examined. It may be asked why the preliminary work can not be done by the shore whaling stations, but it so happens that almost every cetacean known is commercially valuable except the killer. From the diminutive porpoise to the huge sulphurbottom all are taken but the orca, and it is left entirely alone. Therefore, the fur-seal question can not be studied on shore, where whales are utilized commercially without special arrangements being made for the capture of the killers.

If the killer be found the great destroyer of fur seals which is suspected, then methods for its destruction should be devised. In lieu of submarines, it might be made the object of target practice of navy gunners. Or a bounty might be offered, so as to make them commercially profitable for whalers to handle. Or what is probably best of all such suggestions, fully equip whaling vessels to scour the seas, just as sheep men of the west keep coyote hunters constantly on duty.

G. DALLAS HANNA
THE CALIFORNIA ACADEMY OF SCIENCES

SCIENTIFIC EVENTS

LOSS FROM ANIMAL DISEASES

THE Advisory Committee, appointed by the British Development Commission in 1920, has issued its report on the facilities now available for the scientific study of the diseases of animals, and improvements recommended. Sir David Prain was chairman of the committee.

According to an abstract in the London *Times*, the present value of cattle, sheep, and pigs in the United Kingdom is estimated, the report states, at between four and five million pounds. The Scottish Animal Diseases Research Association estimates the annual loss from disease in Scotland at close on £1,000,000, and the committee thinks that the loss in England and Wales must be four times the loss in Scotland. The facilities for research at the five veterinary colleges in the United Kingdom and Ireland "constitute a national disgrace." The sum allocated to veterinary research is "trifling in comparison with the sums set aside for medical, agricultural, and fishery research." There are certain existing facilities at universities, medical schools, the Brown Institution, and attached to the English and Irish Departments of Agriculture and to the Royal Army Veterinary Corps. In South Africa there is a model organization for the study of animal diseases, £123,447 having been spent during the year 1920-21 on veterinary education and research. In India immense opportunities are almost wholly neglected. Leaving out of account the work in South Africa, the state of research into animal diseases within the empire is at present lamentable.

The committee advocates (with reservations by Sir Walter Fletcher) increased salaries to workers of proved capacity at Camden Town, and a capital grant for new laboratories there. It suggests that facilities for research should be placed at the disposal of the Royal Army Veterinary Corps, and that a sum should be set aside annually by the commissioners for special researches into animal diseases.

With regard to the training of investigators, it anticipates that a large proportion will come from the veterinary profession. It is against the increase in the number of universities with veterinary faculties, but wishes more money to be given to the existing veterinary colleges. It proposes that the Development Commission should appoint a diseases of animals research committee, the majority of whom should be men of science. To this new body all applications for grants from the development fund for research into the diseases of animals should be referred.

THE CALIFORNIA STATE FISHERIES LABORATORY

THE State of California, through its Fish and Game Commission, has constructed a laboratory in East San Pedro, at Los Angeles

Harbor, for the study of the biology of the fishes utilized in the now very large sardine and tuna canning industries. The state government has found that such studies are an imperative necessity in the exercise of its legal control over the fisheries. They are necessary, not merely for the determination of biological facts bearing directly upon methods of conservation, but also for the interpretation of the statistics which are now collected by the state for the purpose of observing the condition of the fisheries. The statistical system used is unique, and has proved its independence of the errors usually introduced by statistics gathered by personal inquiry, but the perfection of the data thus gathered does not eliminate, but rather enlarges the importance of biological knowledge and hence of laboratory work.

The building is of reinforced concrete, two stories in height, and of modified Spanish architecture with red tile roof. There are sufficient accommodations for from six to ten research workers in the three laboratories and work room. A large library room, a file room, a dark room and store room are also provided.

It is hoped to collect a library upon fishery subjects which will be very complete, and to that end a number of the important periodicals in the field have been purchased in their entirety. However, aside from the publications of the International Council for the Investigation of the Sea, there are not a great many such periodicals, and the real sparseness of our knowledge of the commercial fishes is emphasized by their lack.

The permanence of the laboratory is assured by the existence of a law specifying the collection of the statistics and the biological investigations necessary. It is felt that it will be very difficult for reactionary interests to repeal the law, or to attack the funds collected by special taxes for the maintenance of the work. Dependence upon appropriations made from year to year has proved disastrous in the case of the federal government and in those of a number of states, and it is to be hoped that such a system as is in existence in California will remain independent of appropriations.

The biological problems which face the fishery expert are wide in scope and will inevitably interest the ecologist and the systematist. For their solution vast quantities of materials are available in the canneries and fish markets, while the detailed records of the catch which are gathered provide a basis for a real science of vital statistics of the fisheries. Men interested along such lines will be cordially welcomed in the new laboratory, in so far as its accommodations are adequate.

Will F. Thompson

MATHEMATICAL PUBLICATIONS

The *Bulletin* of the American Mathematical Society contains several notes concerning mathematical publications from which we quote.

The council of the society has received an offer from an anonymous donor to pay the cost, up to $4,000, of an extra volume of the *Transactions* of the society, to be brought out promptly. This extra volume will be sent without charge to all subscribers and exchanges now on the list.

Mrs. Mary Hegeler Carus, as trustee for the Edward C. Hegeler Trust Fund, has given to the Mathematical Association of America the sum of $1,200 annually for five years for the purpose of publishing a series of monographs whose purpose should be to popularize mathematics by making accessible at nominal cost the best thoughts and keenest researches in this field set forth in expository form comprehensible to teachers and students of mathematics and to other readers of mathematical intelligence. The deed of gift includes the promise to capitalize this annual income by a permanent endowment fund if at the end of five years the project shall have proved successful.

The members of the division of mathematics of Harvard University have constituted themselves an informal committee to solicit contributions to relieve the present financial need of the *Jahrbuch über die Fortschritte der Mathematik*. The deficit for the coming fiscal year will amount to about $1,000. The editor, Professor L. Lichtenstein, has appealed for aid. The Emergency Society for German and Austrian Science and Art, which last year appropriated 20,500 marks for the *Jahrbuch*, contemplates the continuance of its support, sub-

ject to the cooperation of American mathematicians.

On the occasion of the sixtieth birthday of Professor David Hilbert, of the University of Goettingen, his friends, colleagues, and former students presented to him an address, an album of photographs, and a memorial volume of mathematical papers. Among those who joined in these remembrances were over sixty-five American friends and former students. The celebration was directed by a committee consisting of Professors O. Blumenthal (chairman), R. Courant, G. Hamel, E. Hecke, A. Schönflies, and (for America) E. R. Hedrick. The mathematical papers of the memorial volume will appear separately either in the *Mathematische Annalen* or in the *Mathematische Zeitschrift*.

The preparation of the complete edition of the works of Sophus Lie, undertaken in 1912 by Teubner, but suspended because of the greatly increased cost of printing, will be resumed with the financial support of the Norwegian Mathematical Society. The title of the edition will read: *Sophus Lie, Gesammelte Abhandlungen, im Auftrage des Norwegischen Mathematischen Vereins und mit Unterstützung der Akademien zu Kristiania und Leipzig, herausgegeben von Friedrich Engel und Paul Heegaard.* It is planned to publish seven volumes, of which volume three, the first to appear, is now in press.

GRANTS FOR RESEARCH BY THE NATIONAL ACADEMY OF SCIENCES

THE following grants for researches have been approved by the National Academy of Sciences:

Bache Fund

H. Nort, Gouda, Holland, for counting the stars on the Franklin Adams charts..... $ 200

H. S. Jennings, Johns Hopkins University, for studies of the cytology of the rhizopod difflugia..... 500

Herbert M. Evans, University of California, for the determination of the œstrus cycle by means of histological changes in the vaginal and uterine fluid in other mammals than the rat (especially the rabbit and the cat)..... 500

Carl G. Hartman, University of Texas, for the completion of observations on the œstrus cycle of the opossum..... 500

Draper Fund

E. A. Fath, Carleton College, for the purchase of a string electrometer for application to the photometry of the stars..... 375

W. W. Campbell, Lick Observatory, for the purchase of eclipse apparatus..... 450

J. Lawrence Smith Fund

George Perkins Merrill, U. S. National Museum, in aid of further investigations of meteorites..... 500

Gould Fund

Benjamin Boss, Albany, N. Y., for the support of the *Astronomical Journal*..... 1,000

Marsh Fund

Carl O. Dunbar, Yale University, for collection and study of Permian insects..... 150

Miss Winifred Goldring, State Museum, Albany, N. Y., for investigation of Devonian plants of Gaspé..... 75

W. J. Sinclair, Princeton University, for continuation of his studies on the stratigraphic succession of mammalian faunas of the White River oligocene..... 300

Rudolf Ruedemann, State Museum, Albany, N. Y., for studies on the graptolites of North America..... 200

F. Canu and R. S. Bassler, United States National Museum, for continuation of monographic studies on recent and fossil bryozoa..... 150

C. W. Gilmore, United States National Museum, for continued work on a monographic study of the fossil lizards of North America..... 300

Joseph Henry Fund

Carl T. Compton, Palmer Physical Laboratory, Princeton, N. J., for researches on the electric moments of molecules..... 1,000

H. J. Muller, University of Texas, for the purchase of a microscope designed especially for selective illumination of given cells or portions of cells by means of visible or ultra-violet light for use in studies in cytology, embryology and genetics..... 250

Aleš Hrdlička, United States National Museum, for support of investigations relating to the origin and antiquity of man on the American and Asiatic continents..... 500

THE ELIAKIM HASTINGS MOORE FUND

ON the occasion of the twenty-fifth anniversary meeting of the Chicago Section of the American Mathematical Society, held in Chicago on April 14 and 15, 1922, the following resolutions, with the names of 174 contributors, were presented to Professor E. H. Moore in a beautifully bound and illuminated manuscript:

Conscious of the great influence which you have exercised upon the development of mathematical science throughout this country, particularly in the Middle West during the last twenty-five years,

Admiring the outstanding qualities of your researches in various fields of mathematics,

Grateful for the inspiration and the encouragement which you have given to those who have come to the University of Chicago to study mathematics,

Recognizing the large contribution which you have made to the creation and the growth of the Chicago Section of the American Mathematical Society,

Deeply appreciative of the friendship which, during many years, you have shown toward those who have had the good fortune to know you,

The undersigned members of the American Mathematical Society, formerly students of mathematics at the University of Chicago, or members of long standing in the Chicago Section, have wished to use the opportunity afforded by the twenty-fifth anniversary meeting of the Chicago Section to present to you a testimonial, which is intended to link your name in the years to come with the development of mathematics in this country.

To this end they have contributed to a fund which is to be offered for trusteeship to the American Mathematical Society upon the following conditions:

1. The fund is to be known as the Eliakim Hastings Moore Fund.

2. The interest on the fund is to be used at the discretion of the council of the society, and upon the recommendation of a committee appointed from time to time for this purpose, in furtherance of such mathematical interests as

(*a*) The publication of important mathematical books and memoirs.

(*b*) The award of prizes for important contributions to mathematics;

it being further recommended that during the next ten years preference be given to the former, and that publication of Professor E. H. Moore's researches in general analysis or other fields shall have precedence over all other claims.

3. The fund is to be kept intact by the American Mathematical Society except in so far as it is used to aid in the publication of Professor Moore's researches. For this special purpose a part of the principal, not exceeding one third, may be used provided the interest on the remainder be allowed to accumulate until the fund has been restored to its original value.

The trusteeship of the Eliakim Hastings Moore Fund was accepted by the council of the American Mathematical Society at its meeting on April 15. The society intends to keep the fund, which now amounts to nearly $2,000, open for further contributions so that it may become the nucleus for a much larger fund at the disposal of the American Mathematical Society for aid in the publication of important mathematical work. Contributions may be sent to the secretary of the society, Professor R. G. D. Richardson, Brown University, Providence, Rhode Island.

ARNOLD DRESDEN

SCIENTIFIC NOTES AND NEWS

AT the recent meeting of the National Academy of Sciences, Dr. Joseph S. Ames, professor of physics at the Johns Hopkins University, and Mr. Gano Dunn, president of the J. G. White Engineering Corporation, were elected members of the council. Delegates from the academy were appointed as follows: To the seventh centenary of the University of Padua, May 14 to 17, 1922, H. D. Curtis and F. H. Seares; to the hundred and fiftieth anniversary of the Académie Royale des Sciences de Belgique, May 24, R. A. Millikan; to the sessions of the International Research Council, Brussels, beginning July 18, George E. Hale and R. A. Millikan.

FROM the fund collected by the women of America to present a gram of radium to Mme. Curie, there remains, after about $110,000 had been paid for the radium, a surplus of about $50,000, the annual income from which will be given to Mme. Curie.

SIR BAYLEY BALFOUR, regius keeper of the Botanic Garden at Edinburgh and professor of botany in the university since 1888, has

retired. He is succeeded by his assistant, Mr. W. W. Smith.

SIR RONALD ROSS has been elected a member of the Athenæum Club for "distinguished eminence in science."

SIR HUMPHRY DAVY ROLLESTON was elected president of the Royal College of Physicians of London on April 10, succeeding Sir Norman Moore.

THE committee on scientific research of the American Medical Association has made the following grants: $250 to Professor Yandell Henderson, of Yale University, for the purchase of apparatus to be used in investigation of some problems of the regulation of respiration; $225 to Dr. E. B. Krumbhaar, director of laboratories of the Philadelphia General Hospital, for studies on the etiology of inguinal granuloma conducted by Dr. James C. Small; an additional $400 to Dr. Herbert M. Evans, of the University of California, for the continuance of his researches on the relations between ovulation and the endocrine glands.

IN June, Professor Walter S. Haines, of Rush Medical College, will complete fifty years of teaching in the department of materia medica and therapeutics. A banquet of Rush alumni will be held at the Congress Hotel on May 17, during the session of the Illinois State Medical Association, at which it is planned to give recognition to this unusual record of service.

ABOUT three hundred men and women, including physicians, social workers and members of the nursing profession, attended a dinner on April 26, given to Dr. S. Josephine Baker, head of the bureau of child hygiene of the New York City Health Department. Dr. Baker has been appointed by State Health Commissioner Herman M. Biggs as consultant in child hygiene in connection with the organization of a new division in the state department of health provided by the Davenport law.

DR. JOSEPH C. SWENARTON has been appointed assistant director of the bureau of bacteriology of the Baltimore City Health Department.

L. E. ROBERTS, formerly assistant director of research of the American Writing Paper Company, Holyoke, Mass., is now physical chemist at the Pacific Coast Experiment Station of the Bureau of Mines at Berkeley, Calif.

R. E. HALL, formerly with the Geophysical Laboratory of the Carnegie Institution at Washington, has been appointed to take charge of the physical laboratory of the Pittsburgh station of the Bureau of Mines.

PROFESSOR JOHN FRAZER, dean of the Towne Scientific School of the University of Pennsylvania, has been appointed engineering exchange professor to France next year. In this capacity he will represent seven American technical schools.

DR. HARRY RICHMOND SLACK, JR., A.B. (Georgia, '08), M.D. (Johns Hopkins, '12), associate professor of laryngology of the Johns Hopkins Medical School, has been appointed exchange professor to the Union Medical College, in Peking, China. Dr. Slack will be professor of otolaryngology and organize and preside over that department. He will sail from San Francisco about August 1 and be gone for a year.

DR. MARY E. COLLETT, of the University of Buffalo, will spend next year in Sweden as fellow in physiology of the American-Scandinavian Foundation.

PROFESSOR C. E. FERREE, of Bryn Mawr College, has been appointed one of an international commission of four for the standardization of the work on field taking, to report at the Thirteenth International Congress of Ophthalmology to be held in London in 1925.

KURD H. ENDELL, professor of economic engineering at the Technical High School of Berlin, recently made an inspection of many of the open pits and underground properties on the Mesabi iron range in Minnesota and the iron-ore loading docks at Duluth and Superior.

At the recent national convention of Sigma Gamma Epsilon at Pittsburgh, Pennsylvania, the new grand council was constituted by the election of Dean H. B. Meller, University of

Pittsburgh, *President;* Harry Crum, Lawrence, Kansas, *vice-president;* Dr. C. E. Decker, University of Oklahoma, *secretary-treasurer;* E. F. Schramm, University of Nebraska, *historian,* and Dr. W. A. Tarr, *University of Missouri,* editor.

PROFESSOR A. GURWITSCH, formerly professor of anatomy and histology in Petrograd, is now on the faculty of the newly founded university at Simferopol, Crimea, Russia. As the university library is without recent scientific publications, he would welcome the receipt of reprints, books or periodicals from his colleagues in the United States.

DR. VERNON KELLOGG, permanent secretary of the National Research Council, gave an address before the Graduates Club of Ohio State University on May 2, and the annual Phi Beta Kappa address at Oberlin College on May 4. He will give the annual Phi Beta Kappa address at the University of Virginia on June 12.

ON APRIL 26, Dr. Frederick Bedell, of Cornell University, spoke before the staff of the California Institute of Technology and the Mount Wilson Laboratory on "Some alternating current phenomena."

DR. FREDERICK V. COVILLE on April 26 delivered a lecture on "The influence of cold in stimulating the growth of plants" before the Kansas chapter of the honor society of agriculture, Gamma Sigma Delta, at the Kansas State Agricultural College.

DR. BRAYTON H. RANSOM, of the division of zoology of the Bureau of Animal Industry, United States Department of Agriculture, gave a De Lamar lecture on April 24, at the School of Hygiene and Public Health of the Johns Hopkins University, entitled "The hygienic importance of recent discoveries in ascariasis."

DR. E. P. LYON, dean of the College of Medicine of the University of Minnesota, delivered the annual Alpha Omega Alpha address before the Alpha Chapter of the University of Nebraska College of Medicine on April 21, on the subject "Humidity as a physiological factor."

PROFESSOR E. B. TITCHENER, Sage professor of psychology, Cornell University, delivered a lecture on "The structure of the physiological psychology" on April 8 before an open meeting of the William James Club of Wesleyan University.

AT the recent meeting of the Michigan Academy of Sciences, Dr. J. McKeen Cattell gave the evening lecture under the auspices of the University of Michigan, his subject being "The uses of psychology."

THE Morison lectures before the Royal College of Physicians of Edinburgh were delivered by Professor G. Elliot Smith, on May 1, 3 and 5, the subject being "The evolution of the human intellect."

GEORGE R. DAVIS, engineer in charge of the Pacific division of the U. S. Geological Survey, died recently in San Francisco.

ADOLPH B. AMEND, for more than twenty years with the house of Eimer & Amend, New York City, died at his home in Brooklyn on April 19.

DR. ANDREW MCWILLIAM, consulting metallurgist and formerly professor of metallurgy in Sheffield University, died at Sheffield on April 5.

THE death is announced of Dr. Francis Darby Boyd, Moncrieff-Arnott professor of clinical medicine in the University of Edinburgh, at the age of 55 years.

A MONUMENT to the memory of the late Professor George Trumbull Ladd, professor of moral philosophy and metaphysics at Yale University from 1881 to 1906, whose death occurred in New Haven on August 8, 1921, was unveiled in the grounds of a Buddhist temple near Tokyo, Japan, on March 11, in the presence of Mrs. Ladd, Mr. Charles Beecher Warren, American ambassador to Japan, and Japanese friends of Professor Ladd. Speeches were made by the American ambassador and a number of Japanese officials, and Mrs. Ladd gave a brief response. The monument consists of a slab of gray, volcanic rock. It stands on the top of the hill of the bell tower in the grounds of Soji-ji, the great Buddhist temple at Tsurumi. Beneath the slab are a part of the ashes of the psychologist and philosopher, brought to Japan at his request.

THE Ramsay Memorial trustees will at the end of June consider applications for two Ramsay Memorial fellowships for chemical research. One of the fellowships will be limited to candidates educated in Glasgow. The value of the fellowships will be £250 per annum, to which may be added a grant for expenses not exceeding £50 per annum. Full particulars as to the conditions of the award are obtainable from Dr. Walter W. Seton, secretary, Ramsay Memorial Fellowships Trust, University College, London.

THE Liverpool School of Tropical Medicine has awarded the Mary Kingsley medal to the Oswaldo Cruz Institute of Rio de Janeiro in appreciation of the scientific work of the late Dr. Oswaldo Cruz. Dr. Carlos Chagas is the director of the institute now, and the letter accompanying the medal states that the Liverpool school had decided to award this medal "For Devotion to Science" to Dr. Cruz, but was waiting for the close of the war before making any awards. The letter continues: "In the meantime Dr. Cruz had died, and the school now confers the medal on the Oswaldo Cruz Institute as a tribute to the memory of one of the greatest sons of Brazil. As the institute founded by him is destined to be the leading one of the institutions for medical research in tropical America, it is only just that it should receive this token of appreciation."

W. A. CRUSE, secretary of the Petroleum Section of the American Chemical Society, announces that members of the special committee for promotion of research on petroleum in cooperation with Dr. Van H. Manning, director of research for the American Petroleum Institute, are as follows: W. F. Faragher, chairman, Mellon Institute, Pittsburgh, Pa.; R. E. Wilson, Massachusetts Institute of Technology, Cambridge, Mass.; R. P. Anderson, United Natural Gas Company, Oil City, Pa.; N. A. C. Smith, Bureau of Mines, Pittsburgh, Pa.; C. E. Waters, Bureau of Standards, Washington, D. C.; R. R. Matthews, Roxana Petroleum Company, Wood River, Ill.; E. W. Dean, Standard Oil Company, 26 Broadway, New York, N. Y. At the recent meeting of the American Chemical Society in Birmingham, the Petroleum Section authorized the appointment of such a committee.

THE Biological Research Institute (Biologische Versuchsanstalt) of the Vienna Academy of Sciences, affords exceptional opportunities for students to pursue investigations in experimental biology on both animals and plants. Research tables may be occupied by properly qualified persons at a monthly rental of $20. Inquiries should be addressed to the director, Professor Hans Przibram, II. Prater, Vivarium, Vienna, Austria.

UNIVERSITY AND EDUCATIONAL NOTES

MR. E. W. SCRIPPS has established a foundation at Miami University for the study of population in its various aspects, particularly the population of the United States. Dr. Warren S. Thompson, professor of rural sociology at Cornell University, has accepted the appointment as director of the foundation.

DR. SYDNEY WALKER, JR., has provided for a scholarship in the department of physiology of the University of Chicago, to be known as the Sydney Walker III scholarship in physiology, in memory of Dr. Walker's son. It is to be used for the furtherance of research in physiology and provides $200 a year.

THE inauguration of Dr. Clarence C. Little, formerly of the Cold Spring Harbor Biological Laboratory, as president of the University of Maine, will take place on May 10.

PROFESSOR D. WRIGHT WILSON, Ph.D., professor of physiological chemistry, Johns Hopkins Medical School, Baltimore, has been appointed to fill a similar position at the University of Pennsylvania, to succeed Dr. Alonzo E. Taylor.

DR. ALBERT SCHNEIDER has resigned from the University of Nebraska. He will teach in the summer session of the University of California, and will then go to Portland, where he has accepted a position in North Pacific College and where he will continue his cancer research.

DISCUSSION AND CORRESPONDENCE

DID HUMPHRY DAVY MELT ICE BY RUBBING TWO PIECES TOGETHER UNDER THE RECEIVER OF AN AIR PUMP?

It is commonly stated that Humphry Davy melted two pieces of ice by rubbing them together under the exhausted receiver of an air pump, and thus showed conclusively that heat is not a material substance. In books which I happen to have at hand I find twelve different authors stating that Davy melted two pieces of ice by rubbing them together in a vacuum, and four of them stating in addition that the two pieces of ice were rubbed together by clockwork. In looking to see what Davy himself said about this experiment I have, to my surprise, failed to find any evidence that he ever performed just this experiment.

Of the authors whom I consulted, four give references. Two refer to the Collected Works of Sir Humphry Davy, vol. 2, p. 11. The other two refer to Davy's Elements of Chemical Philosophy. In the Elements of Chemical Philosophy, reprinted as Volume 4 of the Collected Works, I have not found any statement about the melting of ice by friction. In the first paper in Volume 2 of the Collected Works Davy describes twenty-two experiments and makes comments on them.

In Experiment 2, p. 11, he describes an experiment in which "by a peculiar mechanism" he caused two blocks of ice to rub together. "They were almost entirely converted into water." In the description of this experiment nothing is said about any air pump.

The description of the third experiment is not entirely clear. Davy says, "I procured a piece of clock-work so constructed as to be set to work in the exhausted receiver; one of the external wheels of this machine came in contact with a thin metallic plate. A considerable degree of sensible heat was produced by friction between the wheel and plate when the machine worked uninsulated from bodies capable of communicating heat. I next procured a small piece of ice; round the superior edge of this a small canal was made and filled with water. The machine was placed on the ice, but not in contact with the water. Thus disposed, the whole was placed under the receiver. . . . . The receiver was now exhausted. . . . . The machine was now set to work. The wax rapidly melting, proved the increase of temperature."

From this description it seems that the clockwork was not a mechanism for rubbing two pieces of ice together, but was used to produce friction between two metals, and that the heat developed by this friction caused the melting of some wax.

Any clockwork which Davy might have placed inside of the receiver would probably not have been sufficiently powerful to melt ice rapidly by rubbing it on ice. I have wondered if some author did not read the second experiment, glance at the third, and seeing the words *clockwork, exhausted receiver, ice* conclude that two blocks of ice were rubbed together by clockwork under the exhausted receiver. If so, this is an interesting illustration of the ease with which a misstatement may pass from one author to another. If there is evidence that Davy did melt two blocks of ice by causing clockwork to rub them together under the receiver of an air pump I hope some one will adduce it.

Arthur Taber Jones
Smith College,
February 23, 1922

A PARACELSUS LIBRARY IN THIS COUNTRY

In your issue of February 10, F. N. Garrison announces a new prospective publication in Germany of the complete works of Paracelsus, that great pioneer in analytical chemistry and medical reformer of the sixteenth century. It may not be generally known that what is no doubt the largest and most complete collection of the works of Paracelsus in this country is the one made during the last century by the late Dr. Constantine Hering of Philadelphia, and since his death in 1880 was ac-

quired by the Hahnemann Medical College of Philadelphia, where it is now deposited. He spared no effort or expense to make it as complete as possible.

CARL HERING

THE TEACHING OF EVOLUTION IN THE BAPTIST INSTITUTIONS OF TEXAS

THE teaching of evolution in the Baptist denominational schools in Texas is being investigated as heretical. The denomination is strong in membership and maintains about 15 colleges and seminaries in the state, the chief of which is Baylor University at Waco. It appears that the trouble arose as the result of the publication in 1920, by the Baylor University Press itself, of an "Introduction to the Principles of Sociology," by Grove Samuel Dow, Professor of Sociology in Baylor University. The book is based upon the theory of evolution wherever it touches upon the biological aspects of sociology, although the term biological evolution is scarcely or not at all used in the text. At a recent conference of representatives of the Baptists of all parts of the state, such teachings were pronounced heresy, and a sweeping investigation is being made of all of the Baptist schools of the state to determine how much "heresy" is being taught. Professor Dow has resigned his position.

A somewhat related situation has existed at Southern Methodist University, Dallas, where the teaching of Dr. John A. Rice, Professor of Old Testament Interpretation, has created the severe opposition of a large part of his church. Dr. Rice's book, "The Old Testament in the Life of Today," looks upon the Old Testament as a series of independent historical papers, each subject to its own interpretation. Many are considered as having been revised by several authors before they have reached their present form. Each is regarded as a literary production, subject to all of the rules of literary interpretation; this introduces a personal factor into any understanding of the Old Testament, and completely does away with literal interpretations. Dr. Rice has also left his position, to become pastor of a Methodist church in another state.

S. A. R.

THE METRIC CAMPAIGN

MR. HALSEY'S recent letter in SCIENCE is of interest in view of the hearings that have been held during the past few months on the Britten-Ladd Bill. It was made clear in these hearings that wire, for instance, is readily defined as a 2 millimeter wire (2 mm in diameter) or, by a less convenient method, as a wire 0.079 inch in diameter. An inferior method is to refer to such a wire as a No. 46 Stubs' wire (2.01 mm or 0.079 inch) or a No. 14 Birmingham (Stubs') wire (2.11 mm or 0.083 inch). There are at least three other gages that have been used to a greater or less extent. It was shown in the metric hearings that if this convenient metric method continued to prevail, certain gage manufacturers would lose the advertising value connected with the use of their gages. It furthermore developed that it was a gage manufacturer who had organized what opposition he could in order to fight the metric system, had contributed $1,000 from his firm and had brought about the employment of Mr. Halsey in his metric fight. Mr. Halsey had profited by his anti-metric efforts in the past. His own words in this controversy were "We have killed the metric system before and we will kill it again." We have no objection to Mr. Halsey's attempted slaughter of the metric system. Readers of SCIENCE, however, may be unaccustomed to his method of argument. In his recent letter, for instance, he endeavors to make it appear that Professor E. C. Bingham of Lafayette College is "naïve" and ignorant regarding weights and measures, and that therefore he should not be encouraged in the successful campaign to secure the use of metric weights and measures throughout the industry in which he is an expert. Professor Bingham's many friends and acquaintances do not need to be told that he is unusually well informed and proficient in his work.

Mr. Halsey's use of the title "Commissioner" is also of interest. This has led a few people to believe for a time that Mr. Halsey in some

way represented a federal, state or municipal organization.

Mr. Halsey refers to a report issued in October, 1921, as confirmation of all his contentions. It is amusing to find that this report was drawn up under the guidance of a committee of five men: the gage manufacturer referred to above, two others associated with him in his fight to kill the metric system, and an impotent minority of two good metric advocates.

However, the use of metric weights and measures, legal for all transactions in the United States since July 28, 1866, is above personalities. As a nation we find ourselves to-day endeavoring to bring about mutual understanding and world-wide trade. At least 46 countries have officially adopted the metric system for general use. Partly through the excellent work of the Decimal Association of London, England has already left America behind in the use of metric weights and measures.

The hearings are over on the Britten-Ladd Bill. The campaign to put this bill, or a modified form of it, through Congress is before our association. At the same time we are cooperating with the Toronto and other sections of the American Metric Association, and an ever increasing number of men and women in North America are using metric weights and measures. We ask for the cooperation of all in the United States and Canada.

HOWARD RICHARDS,
Secretary,
American Metric Association

APRIL 25, 1922

SCIENTIFIC BOOKS

THE BIOLOGICAL RESEARCHES OF GUSTAF RETZIUS

VOLUME XIX, Neue Folge, of the Biologische Untersuchungen of Gustaf Retzius completes the scientific works of the great anatomist and anthropologist who died in the summer of 1919.

This posthumous volume has been edited and compiled at the request of Madame Retzius by Professor Carl Furst, of the University of Lund. Professor Furst is the oldest living friend and colleague of Retzius, and was well equipped, both by virtue of long acquaintance and collaboration with the author, and by familiarity with his work, to edit for publication the series of technical papers which comprise the volume. These papers are seven in number, and are accompanied by twenty-one beautiful plates of folio size.

The first contribution, under the title, "Weitere Beiträge zur Kenntnis von dem Bau und der Anordnung des Ependyms und der sämtlichen Neuroglia, besonders bei den niederen Vertebraten" (Taf. I-XVI), describes the neuroglia and ependyma of various vertebrates in four sections, viz.: A. Amphioxus; B. Myxine; C. Petromyzon; and D. Selachians, Teleosts, Amphibia, Birds and Mammals. The text of section D has been inserted by the editor from a translation into German of an article originally published elsewhere by Retzius in Swedish. The editor states: "Wir bekommen dadurch von Retzius selbst eine Erklärung einiger wichtiger, hier mitgeteilten Figuren. Gustaf Retzius hat mehrmals frühere Arbeiten, die in schwedischer Sprache herausgegeben waren, später in Biol. Unter. in deutscher Übersetzung aufgenommen. Wenn ich diese Abhandlung aus der Müllerschen Festschrift einsetze lasse ich doch grossteils die historische Einleitung der Abhandlung aus. Der Inhalt dieses Historik ist nämlich in den hier oben mitgeteilten Abhandlung ausführlichen mitgeteilt."

The second paper, "Einige Beiträge zur Kenntnis der Structur der Ependym— und Nervenzellen im Rückenmark der Cyclostomen" (Taf. XVII, Fig. 1-24), describes a type of cell among the ependyma cells of the spinal cord of cyclostomes which has been called "inneren Sinneszellen" by several investigators, but which Retzius concludes are modified ependyma cells. The second part of this article considers the fibrillar structure of nerve cells of the spinal cord in this lowly group of vertebrates.

Nine of the folio pages and one plate (Taf. XVIII) describe certain phases of the structure of the lens of the eye, under the title "Zur Kenntnis des Baus des Glaskörpers im Auge des Menschen."

In the fourth and fifth articles (Taf. XIX-XXI) the author continues his already extensive studies on the spermatozoa of various animal groups, under the titles "Die Spermien der Cyclostomen" and "Noch einige Beiträge zur Kenntnis der Spermien bei den Affen," respectively.

"Die Gehirne der Affengattungen Cebus und Ateles" is without figures. It consists of some notes which supplement the author's earlier work, "Das Affenhirn in bildricher Darstellung," in which figures of these brains are found.

The final contribution "Die Verbindungen zwischen dem Sarcolemma und den Grundmembranen der Muskelfibrillen in bildricher Darstellung" (Taf. XVII, Fig. 25-27) is made up of three figures which represent the striated muscle of salamander larvæ, showing the finer structure of the muscle fibers and the relation of the ground membrane to the myofibrillæ and to the sarcolemma. Apparently a paper on this subject was contemplated by Retzius, but the text was not written. The editor refrains from supplying it, stating "Die Bilder demonstrieren selbst so gut diese Verhältnisse dass eine eingehende Erklärung nicht nötig ist. Prinzipiell will ich hier nicht versuchen, Wörte, die Retzius nicht selbst niedergeschrieben hat, ihm in den Mund zu legen." This statement admirably summarizes the attitude of the editor toward the contents of the entire volume.

The volume closes with an excellent table of contents of the two series of the Biologische Untersuchungen, namely, the two volumes which appeared in 1881 and 1882, and the nineteen volumes of the Neue Folge. Following this is a bibliography of the scientific works of Retzius, arranged by subjects. This bibliography consists of 333 titles.

It is fitting that the dedicatory page which in the preceding volumes has borne the names of so many distinguished anatomists should bear in the last volume the inscription by the widow of the author:

Dem Andenken meines verewigten Gemahls
GUSTAF RETZIUS
in Liebe und Dankbarkeit gewidmet.
Anna Hierta-Retzius.

To the sympathetic cooperation of his wife is due in no small measure, together with his own untiring zeal, the unique monument which Retzius has left in the nineteen folio volumes of the Biologische Untersuchungen, and the numerous other papers and monographs which bear his name.

O. LARSELL
UNIVERSITY OF OREGON
MEDICAL SCHOOL

SPECIAL ARTICLES

POLYPLOIDY, POLYSPORY, AND HYBRIDISM IN THE ANGIOSPERMS

FOR some time investigations have been carried on in these laboratories on the subject of polyploidy in relation to polyspory and hybridism. The material used consists of both Dicotyledons and Monocotyledons, and represents either known hybrids or species belonging to genera or groups in which a great deal of natural hybridism is suspected. The conclusion has been reached that polyploidy is a common result of incompatible species crosses. The normal gametophytic number of chromosomes becomes multiplied by three, four, etc., as a consequence of such inharmonious crosses, in various degrees of complexity. A frequent, although not invariable accompanying feature of polyploidy is the phenomenon of polyspory.

As is well known, the normal divisions taking place in the spore-mother cells of the Angiosperms, lead to the formation of four spores. Some of the members of the normal tetrad of spores may exceptionally abort, as for example, in the microspores of certain sedges. This condition of abortion is the normal one in the formation of megaspores. In the case of polyspory the first division of the spore-mother cell leads to the formation of more than the two normal daughter nuclei. Two larger nuclei are generally formed by the union of certain of the chromosomes which undergo separation into daughter groups at a moment preceding that in which the remaining chromosomes pass into the metakinetic phase. The later dividing chromosomes, in separating tardily into daughter groups are ordinarily

fewer in number than are those concerned in the formation of the two main daughter nuclei. The nuclear bodies formed by their fusion lie ultimately lateral to the spindle instead of terminal as in the case of the larger nuclei, and are of strikingly small size. There may be as many as four of the small nuclei at the end of the first division of the pollen mother-cells. When the second division takes place a further formation of normal large nuclei (aggregating four in number), and of abnormal small nuclei more numerous than are the large nuclei results. The large nuclei give rise usually to normal pollen grains but some or all of the grains resulting from them may abort. The small nuclei derived from the late-dividing and small groups of chromosomes give rise apparently always to abortive grains. A number of publications from this laboratory[1] have emphasized the importance of pollen sterility as a reliable morphological criterion of previous heterozygosis or genetical impurity.

Special attention has been devoted to abortive pollen as evidence of hybridism in the case of the Onagraceæ and Rosaceæ, but it is likewise found in many other groups. It is interesting to note that Tackholm in Sweden[2] and Blackburn and Harrison[3] in England, have recently pointed out the coincidence of hybridism and polyspory in the genus Rosa. Our investigations have made this condition clear for a considerable range of Dicotyledons and Monocotyledons. Tackholm has asserted on the basis of his extensive studies that all the roses belonging to the Canina section of the genus Rosa, in other words, the roses of Europe, of western Asia, and of northern Africa, are throughout hybrids probably thousands of years old and reproducing by apparently normal seeds, which are nevertheless formed "apomictically" and without the intervention of a sexual act. Obviously such seeds will "come true" as universally as do grafts or vegetative multiplications of any kind and for the same reason because they represent only subdivisions of the vegetative body.

Polyspory appears as a consequence of our investigations, which will be published in full at a later stage, as a frequent although not invariable result of hybridization of species (that is, of species crosses), and constitutes one more valuable structural or morphological criterion of heterozygosis. It frequently accompanies polyploidy and the manifestations of the so-called "lethal factor" in marked reproductive sterility in either known or suspected hybrids between species of the higher plants.

We have now the following morphological criteria of genetical impurity or heterozygosis in plants, namely, reproductive sterility (most easily observed in the case of the microspores or pollen), gigantism, variability (mutability), polyploidy and polyspory. Not all of these may occur in any given case, but the coincidence of any considerable number of these features should be regarded as supplying strong evidence of previous crossing of more or less incompatible species or varieties.

E. C. JEFFREY
A. E. LONGLEY
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LABORATORIES OF PLANT MORPHOLOGY,
HARVARD UNIVERSITY

[1] Jeffrey, E. C., Spore Conditions in Hybrids and the Mutation Hypothesis of De Vries, *Bot. Gaz.*, Vol. 53, No. 4, October, 1914; Some Fundamental Morphological Objections to the Mutation Theory of De Vries, *American Naturalist*, 1915.

Standish, L. M., What is Happening to the Hawthorns? *Journal of Heredity*, Vol. 7, No. 6, June, 1916.

Hoar, C. S., Sterility as the Result of Hybridization and the Condition of Pollen in *Rubus*, *Bot. Gaz.*, Vol. 62, No. 5, November, 1916.

Forsaith, C. C., Pollen Sterility in Relation to the Geographical Distribution of Some *Onagraceæ*, *Bot. Gaz.*, Vol. 52, No. 6, December, 1916.

Cole, R. D., Imperfections of Pollen and Mutability in the Genus *Rosa*, *Bot. Gaz.*, Vol. 63, No. 2, February, 1917.

Jeffrey, E. C., Evolution by Hybridization, *Brooklyn Botanic Garden Memoirs*, 1: 298-305, June 6, 1918.

[2] Tackholm, Gunnar, On the Cytology of the Genus *Rosa*. A Preliminary Note, *Sartryck ur Svensk Botanisk Tidskrift*, Bd. 14, 2-3, 1920.

[3] Blackburn, K. B., and Harrison, J. W. H., The Status of the British Rose Forms as determined by their Cytological Behaviour, *An. Bot.*, Vol. 35, No. 138, April, 1921.

THE REACTION OF DROSOPHILA TO ULTRAVIOLET

ALTHOUGH there is no unanimity of opinion as to the ability of insects to distinguish colors in the sense that humans do, it is fairly well established that the tendency is for them to react most strongly to wave-lengths in the violet end of our visible spectrum. This suggests the possibility that insects may be sensitive to ultraviolet, to which the human eye is relatively insensitive except indirectly by fluorescence in the cornea. The possibility is of interest in connection with the general problem of the biological relations between flowers and insects, for flowers may be "ultraviolet" as well as red, yellow, and so on. A committee of the National Research Council is planning to do field-work on this problem during the coming summer and it was thought that the following experiments might give useful preliminary information. They were made with the assistance of Mr. Ware Cattell.

Drosophila melanogaster exhibits a strong tendency to move toward the source of light. A large number of these flies were placed in a test tube about 30 cm. long and 2 cm. diameter, the end being closed with a plug of cotton. A strip of black paper was rolled around the tube to protect from stray light. By slipping the paper down from the end of the tube the flies could be "concentrated" next to the cotton plug. The paper was then replaced and the tube placed *horizontal* with its rounded end toward the spark from a 200 watt General Electric ultraviolet generator. Between the generator and the tube were placed four thicknesses, totaling about 1 cm., of Corning ultraviolet glass, number G586A (old number G55A62). After an exposure of 15 seconds the flies were found to have congregated in the end of the tube next to the source, showing that they were strongly attracted by the ultraviolet generated by the spark and transmitted by the special glass.

The transmission of this glass has been measured by the Bureau of Standards (Technological paper Number 148: "The Ultraviolet and Visible Transmission of Various Colored Glasses"). A thickness of one centimeter transmits about 70 per cent. of light in the neighborhood of 0.36; about 25 per cent. near .34; but only 5 per cent. at 0.40. This glass transmits also a small amount of red. The flies, however, did not react when we used a red glass which transmitted far more red than G586A.

To make a more accurate test, a quartz spectrograph was used to disperse the light from the ultraviolet generator. Light of wave-length greater than .39 was excluded by a strip of black paper in the focal plane. As before, the flies showed a very marked reaction when the horizontal test was "pointed" toward the ultraviolet source.

This last result was, however, rendered somewhat doubtful by the fact that the quartz lenses and the dispersing system scattered a small amount of blue and violet light. This scattered light was entirely eliminated, at least so far as human vision is concerned, by interposing a single thickness, 2.5 millimeters, of G586A in the path of the light. But even then the flies showed a marked reaction. The conclusion is that *Drosophila melanogaster* is more sensitive to ultraviolet light than is the human eye.

The question may still be raised that these phototropic reactions of *Drosophila* are due to fluorescence of eye media, similar to that experienced by the human eye when exposed to ultraviolet light. All that can be said at present in this connection is that the intensity was so low that we did not experience the visual sensation characteristic of such fluorescence, but the flies reacted promptly and definitely.

F. E. LUTZ,
AMERICAN MUSEUM OF NATURAL HISTORY
F. K. RICHTMYER,
CORNELL UNIVERSITY

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION A—MATHEMATICS AND ASSOCIATED SOCIETIES

SECTION A of the American Association for the Advancement of Science met in Room 8 of the Main Building of the University of Toronto on Thursday afternoon, December 29, 1921, in joint session with the American Mathematical Society and the Mathematical

Association of America. Professor Oswald Veblen, chairman of the section, presided.

The program comprised the following addresses:

1. *A mechanical analogy in the theory of equations,* by Professor D. R. Curtiss, retiring vice-president of Section A.
2. *The research information service of the National Research Council,* by Professor R. M. Yerkes, of the National Research Council.
3. *Subsidy funds for mathematical projects,* by Professor H. E. Slaught.
4. *Algebraic guides to transcendental problems,* by Professor R. D. Carmichael, retiring chairman of the Chicago Section of the American Mathematical Society and vice-president of the Mathematical Association of America. In the absence of Professor Carmichael, an abstract of his paper was read by Professor Arnold Dresden.

At a meeting of the sectional committee preceding this program, the following nomination was made for chairman of the section, to preside as vice-president for Section A at Boston and to give his retiring address at Cincinnati: Professor G. A. Miller, of the University of Illinois. At a business meeting of the section following the program this nomination was approved, and Professor Miller was elected at a meeting of the council of the association, held on December 30.

A joint dinner for mathematicians and physicists was given at Burwash Hall on Friday evening, December 30.

Wm. H. Roever,
Secretary

SECTION B—PHYSICS—AND ASSOCIATED SOCIETIES[1]

Section B of the American Association held its session on Thursday morning, December 29, 1921, in conjunction with Section C of the American Association, the American Physical Society, the American Meteorological Society, and the Section of the Physical Science Committee of the National Research Council. Professor John C. McLennan, of the University of Toronto, retiring vice-president for Section B, delivered his address on "Atomic nuclei and extranuclear electronic configuration." The vice-presidential address was followed by a symposium on the Quantum Theory, with the following speakers: (A) R. C. Tolman, director, Fixed Nitrogen Research Laboratory, Washington, representing Section C (Chemistry), A. A. A. S., "Review of the present status of the two forms of the Quantum Theory"; (B) H. B. Phillips, Massachusetts Institute of Technology, Cambridge, representing the American Mathematical Society, "Mathematical aspects of the Quantum Theory"; (C) Saul Dushman, The General Electric Company, Schenectady, N. Y., representing the American Physical Society, "Some recent applications of the Quantum Theory to Spectra." This meeting proved to be of very great general interest.

At the business meeting of Section B, C. A. Skinner, of the Bureau of Standards, was elected to be a member of the section committee, his term of office to end January 1, 1926. Dr. F. A. Saunders, of Harvard University, is the vice-president for Section B for 1922.

The American Physical Society.—This society held sessions beginning Wednesday, December 28, and continuing until Friday afternoon. The annual business meeting of the society was held on Friday, December 30, at which time the following officers were elected: *President,* Theodore Lyman, Harvard University, Cambridge, Mass.; *Vice-president,* Charles E. Mendenhall, University of Wisconsin, Madison, Wis.; *secretary,* Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio; *treasurer,* George B. Pegram, Columbia University, New York, N. Y. The president of the American Physical Society gave an address on "The spectroscopy of the extreme ultra-violet." The physicists' dinner was held on Friday evening at Hart House. During the sessions of the society 77 scientific contributions were read.

American Meteorological Society.—Sessions were held beginning Wednesday morning, December 28, and continuing through Thursday afternoon. The annual business meeting was held on Thursday morning, and the following officers were elected: *President,* Sir Frederic Stupart, 315 Bloor Street, Toronto, Canada;

[1] Toronto, December, 1921.

Vice-president, W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.; *Secretary and Treasurer,* Charles F. Brooks, Clark University, Worcester, Mass. On Thursday morning Professor Robert DeC. Ward, of Harvard University, gave his address on "Tendencies and progress in climatology during the past decade." The meteorological luncheon was held on Wednesday at 1 p.m. at Hart House. On Wednesday afternoon the society held a symposium on "Improvements in synoptic weather charts, especially on the reduction of atmospheric pressure observations," at which the following papers were read: (1) "The history of barometry in the United States," C. Leroy Meisinger, U. S. Weather Bureau, Washington, D. C.; (2) "Reduction of barometer to sea-level," C. F. Marvin, U. S. Weather Bureau, Washington, D. C.; (3) "Upper air pressure maps as possible aids in the solution of the barometry problem," C. LeRoy Meisinger, U. S. Weather Bureau, Washington, D. C.; (4) "Sea-level vs. the Megadyne base," Alexander McAdie, Harvard University, Blue Hill Observatory, Readville, Mass. (By title); (5) "Major wind streams vs. high and low pressure centers as the basis for weather forecasting," W. G. Reed, Philadelphia, Pa. (By title); (6) "Cloud movements as aids in forecasting," C. F. Brooks, Clark University, Worcester, Mass. Fifteen other scientific papers were read during these sessions.

Section of the Physical Science Committee of the National Research Council.—Meetings were held in Hart House, Prof. H. G. Gale acting as chairman.

It seemed to be the consensus of opinion that the Toronto meeting had been an exceptionally interesting and inspiring one. Contributing to the success of the meeting was the untiring work of the local committees and the cordiality of the members of the University of Toronto and the Royal Canadian Society. The international character of the Toronto meeting was noted by the presence of more Canadians than usual and by the distinguished visitors from abroad.

The secretary wishes to thank especially those who at the last minute took upon themselves the work of preparing papers for the joint meeting of Section B with the Associated Societies.

S. R. WILLIAMS,
Secretary, Section B

SECTION K—SOCIAL AND ECONOMIC SCIENCES

No separate session of Section K was arranged for the Toronto meeting on account of the recent death of the secretary, Dr. Loomis. A joint session of the section was held, however, with Section Q (Education) on Friday afternoon, December 30, 1921. At this meeting Dr. Frederick L. Hoffman, the recently elected secretary of the section, read an extended address on "The Organization of Knowledge," subsequently reprinted in SCIENCE of March 10 and March 17, 1922. Dr. Henry S. Graves of Washington was elected vice-president for Section K for 1922. Dr. Frederick L. Hoffman, dean of the Babson Institute, Wellesley Hills, Massachusetts, was elected secretary; his term of office will expire January 1, 1925. An understanding was arrived at under which the section, during the current year, will concentrate its efforts especially upon conservation problems. The American Metric Association, which is associated with Section K, held sessions on Friday morning and Friday afternoon, December 29. During this session, nine papers were read and much discussion was had suggestive of the slow but gratifying progress of the metric movement. On Friday evening the Metric Association held its annual dinner, participated in by a small but thoroughly interested group of members.

FREDERICK L. HOFFMAN,
Secretary

WELLESLEY HILLS, MASS.

SECTION N—MEDICAL SCIENCES

SECTION N (Medical Sciences) held a symposium on the Health and Development of the Child. Professor A. B. MacCallum, of McGill University, presided. Dr. Joseph Erlanger of Washington University read his vice-presidential address on "The past and the future of the medical sciences," already published in SCIENCE, Vol. 55, page 135, February 10, 1922. The following papers were read:

Hereditary factor in development: C. B. DAVEN-